

Conceptual Framework for Feedback Automation and Personalization for Designing Learning Analytics Dashboards

(paper session)

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Abstract: Fast advancement of educational technologies and Massive Open Online Courses has generated increased interest for exploring learner behavior data to provide **learning process-oriented feedback** mechanisms. By examining how learners interact within virtual learning environments it is possible to reveal feedback needs that can help both teachers and learners throughout learning processes to maximize learning achievements. Attempts for identifying the types and formats of feedback that can be achieved by exploiting learning process data have recently led to increased interest in teacher and/or learner oriented dashboards. Dashboards are considered as instruments that intend to improve decision making by amplifying/directing cognition and capitalizing on human perceptual capabilities (Yigitbasioglu & Velcu, 2012). However, despite the popularity of dashboards and proliferation of solution providers in the market, little is known about their effectiveness, e.g. the typology of feedback relevant for different learning goals, different learners and a teacher.

Furthermore, current dashboard solutions are mostly based on performance indicators of learners leading to decreased mastery orientation by a learner as revealed by recent empirical studies (Lonn, Aguilar, & Teasley, 2015), thus suggesting that learners' goals should be carefully considered when designing learning analytics dashboards. In addition, the interpretability of data visualizations are often neglected in their design. In terms of data collection most studies on learning analytics dashboards are limited to logs and address university settings (Schwendimann et al., 2016) or a specific learning case. Yet, analytical approaches based on which feedback to learner/teacher is proposed are limited to statistical and data mining techniques. Such techniques neglect the procedural and sequential aspects of learning processes and as a result can target a product-oriented rather than process-oriented guidance.

Common to all learning analytics dashboards is the lack of theoretical support grounded in the learning sciences (Sedrakyan, Malmberg, Noroozi, Verbert, Järvelä, & Kirschner, 2016)¹.

In this conceptual paper we consider process-oriented feedback mechanisms provided by dashboards by grounding the idea of feedback on learning sciences and more precisely on *regulatory mechanisms underlying learning processes with awareness of different learning goals and goal orientations. We also complement the idea of feedback by the concepts of effectiveness/efficiency of learning to allow tracking (in)efficient/(in)effective learning processes based on which feedback timeliness can be refined.*

Keywords: learning analytics, dashboards, process-oriented feedback, self-regulation, co-regulation, socially shared regulation, learning goals, effectiveness/efficiency of learning, educational technology, feedback automation

¹ The working paper that contains extended version and detail on the conceptual ideas presented in this paper

Aims: Research on educational dashboards *lack in theoretical support from the recent advancements in the domain of learning sciences and feedback research* (Schwendimann et al., 2016). Furthermore, current *learning analytics dashboards are mostly based on the performance indicators of learners* leading to *decreased mastery orientation* (Lonn, Aguilar, & Teasley, 2015). The work aims at addressing this gap by exploring the following research questions:

1. How, from a learning sciences perspective, can the regulation of learning process be positively influenced by a feedback?
2. What type of feedback can/should be integrated into educational dashboards to support the core regulatory mechanisms underlying learning processes?
3. What type of feedback is best for the learner?
4. What type of feedback is most adequate for or needed by the teacher?
5. What type of data is relevant for learning process observation?

Method: In this work we followed the principles of (1) learning science and (2) design science. We complement engineering approach with learning sciences to design an innovative artefact (dashboard) for process oriented feedback targeting solo and collaborative learning by grounding the idea of dashboard feedback on learning sciences with respect to the concepts of:

1. regulatory mechanisms underlying learning processes, namely, self-, co- and socially shared regulation of learning (Hadwin, Järvelä, & Miller, 2011);
2. typology of feedback based on sociocognitive theories targeting both cognitive and behavioral aspects of learning processes;
3. learning goals, namely, mastery and performance orientation/avoidance (Blumenfeld, 1992; Elliott & Harackiewicz, 1996);
4. effectiveness/efficiency of learning (Frøkjær, Hertzum, & Hornbæk, 2000; Kirschner, Paas, & Kirschner, 2009) allowing to detect (in)efficient learning processes;
5. process data analytics as opposed to data analytics approaches (Sedrakyan, 2016; Sedrakyan et al., 2014, Sedrakyan et al., 2016) that allows detecting sequential/procedural aspects of learning.

Results: The results of the work include a model for measuring learning processes as basis for learning process assessment and (personalized) process-oriented feedback automation. This model can serve as a general framework for designing and building dashboard feedback, as well as can guide future studies in the domain of learning analytics dashboards.

Theoretical and practical significance: The work contributes to the domain of learning sciences with respect to the lack of (1) ***methodologies for learning analytics dashboards feedback*** currently based on performance indicators only, (2) ***feedback automation methodologies*** (to our knowledge inexistent). The conceptual design proposed in the work will allow delivering (personalized) process-oriented feedback to learners as opposed to traditional outcome feedback usually given during learning after a learning task has been completed indicating whether or not results are correct (Butler & Winne, 1995) allowing to enhance learning achievements. The model will also allow delivering feedback to a teacher with respect to feedback needs of learners as well as the relevance/difficulty of a learning design and resources. A prototype solution will enable empirical data collection allowing to obtain new insights and ***improved knowledge on learning processes*** and ***instructional/learning design*** with respect to ***process-oriented feedback*** contributing this way to learning sciences.

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